No. XLVI.

An account of the Freestone quarries on the Potomac and Rappahannoc rivers, by B. H. Latrobe.

Read February 10th, 1807.

ON the 19th of December, 1798, I presented to the American Philosophical Society, a memoir on the sand hills of Virginia, which the Society did me the honor to publish in the fourth volume of their Transactions, page 439.—It was my intention then, to have offered to the Society, a series of geological papers, the materials of which I had collected, and of which this memoir was the first. But my intention was delayed and partly defeated by the loss of a very large collection of all the principal fossils, necessary to elucidate my observations, in their passage by water, from Fredericksburg to Philadelphia.—This collection, intended for the American Philosophical Society, was made by the industry of my excellent friends, Mr. William Maclure now at Paris, of the late Dr. Scandella whose untimely death in 1798 science and friendship equally have to deplore, and of myself.—It consisted of specimens of loose and undecayed fossil shells, found on and near *the surface,* from the coast to the falls of the rivers of Virginia, of the shell rocks of York river, of the clays with impressions of shells in every fracture, but which shew no remaining evidence of any calcareous matter when subjected to chemical tests; of the exuviæ of sea animals*, bones of fishes, sharks' teeth, marsh mud, fossil wood and coral rock, dug from the deep wells about Richmond, of the marles of Pamunky and Mattapony, of all the strata of the coal mines on James's river, of the varieties of the granite of Virginia, of the free stone of James's river and the Rappahannoc, with the vegetable petrefactions and coal belonging to it; and of a variety of miscellaneous fossils.—My object in reciting

* Drawings of some of the exuviæ accompanied my memoir, to which refer.—The bones of the foot there represented, are probably those of a sea tortoise. Vide Vol. IV. p. 444.

this catalogue, is to encourage some member of the Society, who may read it, and whose opportunities of collection are better than my own, to remedy this loss.—All these specimens may be procured with very little trouble in Virginia.

The loss of this collection dispirited me, and the occupations of a most laborious profession deprived me of time. Having now for some years waited in vain, for the leisure necessary to reduce into something like system, the various notes I have made, I must content myself with giving to the Society, unconnected papers, which will contain the facts collectively, proving beyond doubt, that a line drawn along the falls of our rivers, is the ancient line of our sea coast, from New-York to the south west; as it still is from New-York to the north eastward, and that the water of the ocean rose, perpendicularly, at least 120 feet higher along the ancient coast, than it rises along our present coast.—And lest this assertion should appear extravagant, I will here mention, somewhat out of place, that in the year 1796, I followed with a spirit level, in the neighbourhood of Richmond, the pebble stratum, which has all the external appearance of a sea beach, for more than five miles, and found it a *perfect level*, elevated about 120 feet above the tide at Rockets.—The subject of my present communication, is immediately connected with the memoir on the sand hills of Virginia. Its object is, to give to the Society, an account of the freestone quarries on the Potomac and Rappahannoc, from the former of which, the freestone employed in the public buildings of the United States at Washington, is obtained.—The range of sand stone rocks in which the quarries are situated, was, in fact, the ancient sea coast, bounded by sand hills like the present, and the description which I shall give of them, will, I believe, remove all doubt on this subject.

On consulting the map of the middle states, it will be found, that the river Potomac, at the confluence of the river Piscataway, in Maryland, a few miles above Mount Vernon, takes a remarkable turn to the south of west, and continues to run in a south westerly course, as far as the confluence of Acquia creek, on the Virginia side, when it gradually turns to the east of south, and in the course of ten miles lower, pursues a north

easterly direction. At the point at which the Potomac again resumes its course eastward to the ocean, its distance from the river Rappahannoc does not exceed six miles in a straight line. High land separates these streams.—The navigation of the Potomac is much superior to that of the Rappahannoc, and very great advantages would accrue from their junction at this point; but the task of connecting them by a tunnel through this narrow ridge, must be reserved for wealth and population infinitely superior to that of the present age.—From Piscataway to *Potomac creek*, the course of the river Potomac is parallel to that of the sea coast, and measuring along a line running about S. 60° east*, the distance from the present coast will be about 120 miles.—The range of sand stone rock lies on the west side of the Potomac, beginning a few miles below the bend, and continues running in a direction parallel to its south western course, until the river again turns to the eastward.—There it crosses under the ridge which separates the Potomac from the Rappahannoc, reaches and crosses the Rappahannoc, and appears to run out about two miles on the west side of this river.—I have not seen, or heard of its having been found further to the south west for 50 or 60 miles, but it is again found 12 miles above the foot of the falls of James's river, in a situation much higher above the tide, than at the Potomac and Rappahannoc, a situation apparently inexplicable upon any supposition which applies to the sand rocks of these latter rivers; and yet, so exactly similar are these James's river rocks, in all their geological characteristics, that it is impossible not to attribute their formation to the same process of nature. The present state of these rocks is very irregular.—They make their appearance upon the slopes of the vallies and water courses, along the whole line which I have described, in large disrupted masses, or in regular ranges,

* The courses of north 40° east, and south 60° east, form a spherical angle, at which, *with occasional, but never very great variation*, the two principal planes of Rhomboidal crystallization, not only of our rocks of every description, granite, slate, marble, limestone, wacke, and of all those numerous and ambiguous genera of rocks, lying in character, between a distinct granite on one side, and homogenous basaltes on the other, intersect each other, but which decide the position.—I had almost ventured to say the crystallization of the constituent parts of the globe, from the equator to the pole, and from the Mississippi at least to the Atlantic. On inspection of any map of North America, especially if drawn on Mercator's principle, this fact is evident to the eye.

the external parts of which are generally weather-worn, flaky and broken. The most extensive ranges are found in elevated situations.—In the bottoms of vallies the masses that are found there, appear to have fallen or slided down into the water course, and the large masses that form the shore of Potomac and Rappahannoc, are evidently much below their original position.—On quarrying into the rock, the stone is found to be amorphous, often *stratified* with layers of clay or pebbles between the strata, having also frequently upright joints or fractures, so regular as to look like planes of crystallization. The stone is however undoubtedly amorphous and aggregate. The sand stone is covered with a superstratum of alluvial materials, deposited to appearance, subsequent to the formation of the stone; as sand, clay, gravel and pebbles, large and small, rounded by attrition out of many species of mountain stone. Along this superstratum is found the ancient pebble beach, mentioned above, it forms the soil of the high land of the country, is from ten to thirty feet deep, and where it is thinner along the edges and slopes of the vallies, it seems to have been washed away; for in considering the whole country, below the falls of our rivers, we must necessarily perceive, that, if the phrase may be admitted, it has no hills, but only vallies; that is, it was originally a plain, into which the vallies have been gullied by the drainage of water, on the receding and depression of the ocean from its former level of 120 feet above its present elevation. As I am not going to form any hypothesis, the difficulty arising from the existence of the ancient pebble beach, at an elevation considerably above the still more ancient sand beach, presents to me no difficulty in my opinion of the origin of this sand stone.

The component parts of the stone are,

Sand, generally sharp, but often rounded by attrition, of variously sized grains, from very coarse to extremely fine.—This forms the mass and body of the stone:—in this sand is found a variety of extraneous matters.

Clay, in nodules, generally round, sometimes, but rarely, stratified as if deposited. The clay is white and remarkably pure. The clay holes are very troublesome to the stone cutter

and diminish the value of these quarries exceedingly, They are found from the size of a pea, to many inches in diameter.

Pebbles, large and small, of quartz, sand stone, granite, whin, rounded by attrition, and amorphous lumps of quartz.

Pyrites, or lumps of marsh mud mixed with sulphat or sulphuret of iron, effloresceing in the air. Often when one of these pyrites happens to be concealed near the surface of a wrought stone, so that the air and water may reach it, it swells and bursts the stone, thereby defacing the work. This is another disadvantage in using it.

Nodules of iron ore in sand, these nodules dissolve in the air and water, and stain the stone disagreeably. In a spherical hole of the stone, I once found a nest of very beautiful parallelopipedal crystals, quite transparent. I had no opportunity of examining them chemically.

Wood, from trunks and branches of trees of large size, to small twigs, either entirely carbonated, or the wood carbonated and the bark in a fibrous state, so as to have the appearance of a net, and a considerable degree of tenacity; or the bark fibrous, and the wood in a state quite friable; or the wood replaced by pyrites, which effloresce in the air*; or in *cavities,* the sides of which have the impression of branches, in minute ramification, and are lined with a pellucid crust, probably calcareous spar. This latter evidence of the admixture of wood, is to be found chiefly near Fredericksburg.

Iron, appearing in stains, either of masses, or in dark ferruginous spots and clouds; and *clay,* infused through the whole mass, with probably an infusion of lime, which appears to be the cement by which the sand particles are held together; for the acids indicate no existence of carbonate of lime, and I have not yet been able to submit the stone to any chemical examination.

* I had a piece of this species of pyrites, in appearance the branch of a tree, with a small twig attached to it; about 3 inches long. and $\frac{1}{4}$ of an inch diameter, very hard and heavy, I carried it in my pocket for a fortnight, and then threw it into a small box in my office, containing drawing instruments. It remained there for two years, but last summer during very damp and hot weather, it effloresced, and fell into powder, corroding and injuring my instruments exceedingly.

Native allum, is found on the lower projecting surfaces of the rocks, where they are in wet situations, probably produced by the sulphur of the pyrites combining with the clay of aggregation.

The colour of the stone varies from white to a dark rusty tint. Herewith I present to the Society, two blocks, the one of the whitest, the other of the darkest tint. The dark block was, when cut, of a rusty brown, but wishing to weigh the stone in its driest state, I placed it on the plate of an iron stove. In a quarter of an hour its colour was changed almost to black.

The degree of hardness is very various. When moderately hard, its fracture is rough and irregular, when very hard, concave and even, when breathed upon, it has a strong earthy, and somewhat hepatic smell.

The specific gravity of the stone is as various as its colour and texture. The two blocks herewith presented, are very accurately four inches square and two inches thick.—They weigh as follows:—

The brown block 2lb 6.69oz Averd.
white block 2 3.96

———— . . . . difference 2.73oz

54 of these blocks make a cube foot, therefore the difference of weight in one cube foot, between the white and brown stone would be, 9lb 3.42.oz

The white block absorbed in 24 hours, of river water 6.25oz, or at the rate of upwards of 21lb per cubic foot.

One of the most remarkable circumstances belonging to this stone, is the arrangement of the particles of sand of which it consists. In whatever direction a block is cut, the successive accumulations or strata, which may be easily distinguished by the different size of the grains, their colour, the admixture with other substances, and their *individual* parallelism, appear not to lie in beds parallel to each other, but in masses bounded by wavy lines; or which are suddenly cut off by other masses, the lines of which wave in another direction; and this appearance is such, that many stones exhibit by the lines of their strata, a good representation of the wavy hills of the sand coast, as will be seen by reference to the plate in the fourth volume of the Transactions of the Society.

This mode of stratification appears to me to be an incontestible proof, that the wind has been the agent of accumulations of the sand of which the stone consists, as it is now of the sand hills of our present coast. For if it could be supposed, that the agitation of the surf, or of the whirls which occur in all water running through an interrupted course, could have caused this appearance, it would have occurred, as in cases where there is no doubt of aqueous deposition, that the stone would have separated more easily at the lines of stratification than elsewhere. But such is not the case in this stone, for it is as solid at the lines separating the strata as elsewhere.

As the difference of granulation is exceedingly various, often within a very small space, so is also the cohesion of the stone very uncertain. Often with the fairest prospect of a hard sound mass of rock, of great depth and thickness, the quarrier suddenly strikes into a mere friable sand bank. Quarrying is therefore a lottery, in which the blanks are often more numerous than the prizes.

The quality of the stone, as a building material, is also in other respects various. Of the stone most even in its grain and texture, most pleasant to work, and of the most durable appearance, a great part cracks and falls to pieces, on exposure to the sun and air, especially if rapidly dried, after being taken from the quarry. Sometimes contrary to all expectation, the frost tears it to pieces.—All of it expands when wet, and contracts in drying. This property it seems never to lose. When buried in the walls of a heavy building, it is controuled by the incumbent weight, but those blocks that are more at liberty, either at one or both ends, are subject to this variation of size; and the joints of the work open and shut, according to the dryness or humidity of the weather. Window and door selles therefore, which are confined at both ends, and free in the middle, generally break, and the fissure opens and shuts alternately, to the amount, when open, of one tenth of an inch in a block of six feet.

Below the freestone is found, on *Potomac*, most frequently loose sand, sometimes a stratum of round gravel or pebbles,—seldom clay,—very often loose stone very full of carbonated

wood:—on the *Rappahannoc*, loam, marsh mud, quicksand, clay and dry sand:—and *near Mansfield* below Fredericksburg, the largest mass of timber, which I have yet seen:—on *James's river*, sand, gravel, loam. The wood mixed with the stone on James's river, is, I think, less carbonated than on the Rappahannoc and Potomac.—The superstrata are generally, soft clay, loam, and tolerably pure clay, in a state of excessive compactness. On the level country, light loamy sand, and on the slopes of the vallies, *the line of sea beach* above mentioned, often washed and spread over the declivity, often in heaps and ridges. But it will be observed by any traveller, that neither in the bottoms of vallies, out of the beds of the present rivers, nor on the tops of the levels, is gravel to be found.

The superstrata however vary considerably, in one of Mess. Cook and Brent's quarries on Acquia, the following are the strata:—

	ft.	in.
Mould.	0	4
Loam, with some gravel.	3	0
Coarse, irregular, ill compacted, disrupted sandstone	5	0
Gravel, hard clay, lumps of coarse sandstone.	10	0
Four strata of marsh mud, and four strata of excessively hard and pure clay, alternately, one foot thick each lying quite horizontally.	8	0
Loose sand.	3	0
	29	4

Very excellent and solid freeestone, containing fewer clay holes and less wood or iron than ordinary, 8 feet, and running out landwards to 2 feet.

Then sand of great depth.

The best quarry now in work, lies two miles S. W. from Acquia creek, and belongs to Mr. Robertson. Like all others, it is on the top of the slope of a valley, and the face shews as follows:—

	ft.	
Mould.	1	0
Clay, very hard, and some gravel.	2	0
Rough disrupted sandstone.	2	0
Loose sand.	2	0
Sound and excellent rock.	15	0

Under the rock fine loose sand.

In this rock, which runs N. E. and S. W. there is no joint horizontal or perpendicular, and columns of any size, not exceeding 15 feet diameter, might be got out of it, if they could afterwards be removed.—The largest blocks however which I have had taken out, do not exceed in weight four tons.

In working these quarries, the workmen having cut the face perpendicularly, first undermine the rock;—an easy operation, the substratum being loose sand. If the block is intended to be 8 feet thick, they undermine it 5 feet, in a horizontal direction, in order that it may fall over when cut off. They then cut two perpendicular channels on each hand, 1ft. 6in. wide, at the distance from each other of the length of their block, having then removed the earth and rubbish from a ditch or channel along the top of the rock, they cut into the rock itself, a groove, and put in wedges along its whole length. These wedges are successively driven, the rock cracks very regularly from top to bottom, and it falls over, brought down partly by its own weight. Blocks have been thus quarried 40 feet long, 15 feet high, and 6 feet thick. The block which was quarried at my last visit to the quarry, was of the following dimensions:—

26 feet long, × 8 feet deep, × 14 feet high = 2912 feet, which at 15 feet to the ton, agreeably to the quarry rate, amounts to near 200 tons.—These masses are then cut by wedges into the sizes required.

On referring to my memoir on the sand hills of cape Henry, it will be seen that the sand is blown up from the margin of the sea, inland;—that it soon forms a ridge or down of shifting sand, along the shore above high water mark, covering the old surface of the earth with all its vegetation, that in the course of no very great length of time, it accumulates into hills that destroy and swallow up forests in their progress; that its surface is constantly changing with the operation of the wind:—and that, therefore, this sand mass, must contain broken limbs and bodies of trees, iron in greater or less quantity, together with all kinds of extraneous matters, blown up from

the ocean by storms, as clay and mud, mixed with sea water, when a tremendous and muddy surf is blown ashore through the air by violent winds. If we now suppose, that by any operation of nature whatever, these sand hills from a loose state were to become concrete, the rock thus formed, could not in any of its characters differ from that which now forms the freestone quarries of which I am speaking.

These considerations therefore irresistibly impress the belief that both masses are of the same origin.—The disrupture of the ancient hills, is not difficult to account for, if we suppose the ocean to have retired so much below its ancient level, as appearances seem to prove, the sand hills would be undermined by the water from below them, seeking the lower level of the sea, and washed to pieces by the torrents from above. Thus masses of stone, undermined and broken, would fall into the bottoms of the new vallies, and appear on the levels of the present rivers, while others would retain their original situation high above the new level of the sea.—Thus far, rational conjecture will lead us, but further we cannot venture.—Who can answer the questions that then present themselves? If these concreted sand hills were once the ancient shore, rising above the level of the ancient ocean, at what æra was the gravel beach created at their summits? or the marine exuviæ deposited far below their base, as well as upon the mountains rising thousands of feet above their tops? It is fortunate that the solution of these ænigmas of nature are of no consequence whatever to our happiness, or of use to our enjoyments.—But the pleasures of investigation, and of *wonder*, the offspring of ignorance, are not without a charm, which often entices the mere speculative philosopher into researches that produce results beneficial to mankind.

I will here close my description of these sand rocks, and endeavour to find an early opportunity of transmitting to the Society some further remarks upon those of James's river in particular, connected with that most singular and unaccountable region,—the coal region, of which I will only at present hint,

that it appears formerly to have been a spacious lagoon of the sea, of which these particular sand hills are the shore.

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No. XLVII.

Further Observations on the Eclipse of 16th June, 1806, being an Appendix to No. XLIII, page 264 of this Volume, by J. J. de Ferrer.

Read April 17th, 1807.

SINCE the Memoir was printed I have received the following observations.

At the Hydrographic Repository at Madrid, Don Philip Bauza lieutenant in the Royal Navy, observed the beginning of the eclipse at 4^h 27′ 48″ 6, and the end at 6^h 09′ 07″ 2 apparent time. Latitude of the Repository 40° 25′ 08″. Longitude west of Paris 24′ 08″ in time. Magnifying power of the telescope 110.

At the Royal Observatory in the Island of Leon, Don J. M. de la Cuesta, lieutenant in the Royal Navy, observed the commencement 4^h 18′ 42″ 2 apparent time. The end was not observed on account of the clouds. Latitude of the observatory 36° 27′ 45″. Longitude west of Paris 34′ 08″.—Magnifying power of the telescope 53.

I have re-calculated all the observations of page 273, making use of the new solilunar tables, published in Paris, 1806, by the Commissioners of longitude. They are as follows, for 4^h 29′ 41″, mean time in Paris.